Abstract #3039

Influence of photon detection efficiency and multiplexing on spatial resolution in monolithic PET detectors

M. Stockhoff[1], R. Van Holen[2, 1], S. Vandenberghe[1]

[1] *UGent, Medical Image and Signal Processing (MEDISIP), Gent, Belgium*
[2] *Molecubes, Gent, Belgium*

Content

First PET systems in the preclinical domain are now based on monolithic crystal blocks showing a remarkable performance which also makes it potentially interesting for clinical PET, and TB-PET. The advantages are better spatial resolution with intrinsic depth-of-interaction (DOI) information, improved light output and better timing properties. In this study, we use optical simulation to design such a clinical detector with focus on the effect of photon detection efficiency (PDE) and multiplexing. Reducing the electronic read-out channels, and therefore cost per detector is an important factor that scales tremendously in a TB-PET system that can include hundreds of these detectors. The detector consists of a 50 x 50 x 16 mm^3 LYSO scintillation block coupled to a 3 x 3 mm^2 pixel 16 x 16 SiPM array. The detector is calibrated with a pencil beam in 1 mm steps. The acquired events are grouped in 6 DOI layers by their standard deviation. The mean signal is then calculated for each layer and saved in look-up-tables. Positioning is done with a k-nearest neighbors' algorithm. The spatial resolution is evaluated in the central region of the detector by means of FWHM. A detector with 60% PDE shows a spatial resolution of 0.81 mm. The degradation when summing the signal from 256 to 32 channels is ~ 0.1 mm. SiPMs with 100% PDE would have an overall improvement in spatial resolution by ~ 0.2 mm. Layer 1 improves the most (0.3 mm) while the layers closer to the photodetector are less affected by PDE. This can be explained by the higher light spread and thus, low signal-to-noise ratio for individual pixels. The balance between thickness of the detector, pixel size and degree of multiplexing should be carefully chosen to find appropriate positioning accuracy and sensitivity. This monolithic detector is promising for clinical PET systems due to its high spatial resolution and intrinsic DOI information, as well as for the use in TB-PET systems.